

Human Space Flight after ISS

The possible cancellation of the International Space Station (ISS) support in 2024 might be a great ending of the most complex international scientific and engineering project in history as well as the step towards new human space flight achievements. While humans have already inhabited the Low Earth Orbit (LEO) for many years, ambitious plans to Mars colonisation still require further technology development, towards which many players on space arena have their own plans.

This century is dedicated to three possible destinations for human space flight: LEO, Moon and Mars. Earth proximity, short flight duration, radiation protection made LEO a reasonable place for humans. Thus, the continuation of ISS or development of a new space station with modular approach might be an option. Many engineers and scientists assure that the Moon could serve as an intermediate step to future Mars operations. For example, the heavy lift vehicle development needed for a Moon mission might be used for a mission to the red planet. The Moon provides a suitable environment for testing systems with low current technology readiness level, which will be needed for a future Mars mission: In-Situ Resource Utilization system (ISRU), underground habitats, 3D structures printing, etc. The utilisation of reusable rockets, refuelling on orbit and fuel production on Mars eliminates some challenges for Mars colonizers. However, many issues still shall be solved separately from the Moon program; for example, radiation protection. While the Moon base development might take up to 30 years depending on the concept, it is still hard to predict the year of the first mission to Mars.

Most of space agencies and commercial companies announced their plans on human space exploration. NASA set a goal to reach Mars through several intermediate stages, focusing on redirections of asteroids and a circumlunar station design at Lagrange points. Agency has already demonstrated the thermal protection and landing system of Orion in 2014, which shall help to establish the first manned mission by 2021. SpaceX has announced plans for making humans interplanetary species by 2024 using the Falcon Heavy as a launch vehicle. The Moon village, which aims to create first a place for international collaboration as well as to develop a concept of Moon colonization, was proposed by European Space Agency (ESA). Roscosmos has not announced its plans yet, but its current concepts appear to focus on a future LEO platform on one side and on lunar missions based on Federatsia spacecraft on the other, including plans for a lunar station as a step towards future missions to Mars. While China National Space Administration (CNSA) is currently developing their own space station, which shall be fully functioning by 2022, it still takes into account Lunar exploration which include robotic missions to lunar surface as well as high-speed capsule return missions. The German Aerospace Center has suggested a further LEO station “orbital hub”, which will include a habitat, a free-flying module, a service module and a docking interface.

While Mars appears to be the final goal of most of space organisations, direct missions to red planet are currently not feasible mainly due to the budget limitations, which includes the development of necessary technologies. Thus, a transitional step between LEO and Mars, which is relatively economical to accomplish, is required. Building a multipurpose station in the Moon neighbourhood might be an option for improving technology before going for a deep space mission. For example, resupply missions can be tested using advanced propulsion systems. In both missions, robotics plays an important role: a lunar robotic infrastructure might help in developing and testing cryogenic technologies and ISRU, robotic Mars sample return mission can demonstrate electric or nuclear propulsion, cryogenic handling, aero capture manoeuvres, ascent and Mars Orbital Rendezvous. It is important also to solve both habitation and transportation technologies in a systematic and cost efficient way.

International collaboration can provide a sustainable boost in mission funding as well as the ability to use the capabilities developed by the different collaborators. Most probably, such complex missions as Moon or Mars human base cannot be handled by one nation. Thus, in order to succeed in future human space missions it is necessary to continue dialog between space agencies and companies of different countries.